McGovran: Experimentation Branch

April 24, 1947

To: Dr. H. P. Barss and Dr. E. R. McGovran, Office of Experiment Stations

From: Arthur C. Foster, BPIS & E, Beltsville, Maryland

Subject: Phytotoxic effect of DDT and other chlorinated hydrocarbons

Since our telephone conversation recently I have finally gotten around to writing you a resume of our DDT studies. I hope you will find this summary helpful in formulating ideas to encourage other workers to study this very important and complicated problem.

Since DDT has been demonstrated to be so highly effective as an insecticide this fact has encourage industrial manufacturers to produce several basically similiar products. This effort resulted in the fairly rapid development of gamma hexachlorocyclohexane (benzene hexachloride), chlordane and toxaphene. The almost phenomenal efficacy of these insecticides has been widely discussed in the press and by work of mouth. However, the fact that these insecticides might be injurious to plant life, especially as an accumulated soil residue after a period of several years use has received very little attention except by a few investigators.

The phytotoxic effects of all of these products have been under investigation as they became available and considerable data have been accumulated which indicate the toxic effects of these substances to certain crops when applied to the plant foliage as for insect control and also when mixed with the soil to simulate an accumulated soil residue.

The experimental work has been divided into two distinct lines of investigation: (1) the application of DDT to plant foliage as for insect control; and (2) the application of DDT and other chlorinated hydrocarbons to different types of soils at different concentrations. These experiments have been in progress for two years but are to be considered as exploratory in nature and results obtained from them are not to be considered as final and conclusive nor should theyvbe used for establishing any definite policy as to the use of these insecticides.

These insecticides have been widely accepted for application to plant foliage for insect control. Under such conditions of use it was promptly determined that their application would cause injury to certain crops under varying climatic conditions. This type of transitory injury is of little concern except to the individual grower who happens to damage his crop.

If after continuous application of DDT or other chlorinated hydrocarbons to plant foliage for insect control a residue accumulates in the soil that may inhibit plant growth the injurious effect may become permanent and difficult to remove. It appears to be well established that all of these insecticides are stable and resistant to soil microorganisms, they are insoluble in water and will not leach, and the molecule will resit any total disintergration. However, experiments conducted under greenhouse conditions do not necessarily give results that would apply to field conditions. Such results are only a very good indication of what one might expect to get under field conditions. The results obtained from two years experiments have developed certain facts that are hihly important for use in outlining future work for a clearer understanding of the numerous problems accosiated with the use of these insecticides.

A soil residue of as little as 25 lbs per acre of the commercial grade of all of these insecticides will retard or depress the growth of many crops if grown from the seedling stage. This depressed growth is not necessarily accompanied by any symptoms or obvious injuries, the plants will look perfectly normal but only grow slower. In fact, these insecticides will often impart a darker green color to some crops and stunt their growth.

DDT appears to be the least toxic to plants of the chlorinated hydrocarbons developed and now generally and widely used. The technical or commercial grade of DDT appears to be considerably more toxic than the "para para prime [illegible] found in technical grade DDT appear to contribute more to the toxicity of this product than does the para para prime DDT, the accepted insecticidal principle. Furthermore, there is considerable suggestive evidence that the manufacturing processes are not sufficiently uniform to produce a standardized purified technical grade product. This is indicated by the difficulties encountered in obtaining reproducible results from products from different sources, or even different lots from the same source.

Gamma hexachlorocyclohexane and chlordane appear to be the most toxic to plants of the group of chlorinated hydrocarbon insecticides tested. Toxaphene appears to be less toxic than these two but more toxic than DDT. At the present time we do not have information as to the exact nature and amounts of impurities present in these insecticides. It is known only that various isomers and certain impurities are present.

Soil type and character, especially the amount of organic material or colloidal clay present appear to be highly important factors in determing the amounts of these products that can be added to a soil without injury to the germinating seed and the seedlings grown therein. The larger the amount of colloidal clay or organic material present in the soil the greater will be the apparent adsorption of the chlorinated hydrocarbons when the soils are acid. With adsorption there will be less toxicity to sensttive plants.

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[illegible] soil residue of as little as 10 lbs per acre of the commercial grade of all of these insecticides will reduce or depress the growth of many crops if grown from the seedling stage. This depressed growth is not necessarily accompanied by any symptoms or obvious injuries, the plants will look perfectly normal but only grow slower. In fact, these insecticides will often impart a darker green color to some crops and retard their growth.

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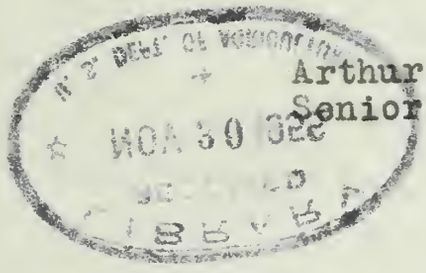
In our limited experience we have found that the change of the pH reaction of the soil has a very merked effect on the apparent adsorption of these chlorinated hydrocarbons and on their toxic effect. If the Ph is high in the soils we have used the compounds will not be adsorbed and will remain toxic. At the present time we are unable to explain definitely the effects of soil reaction and the application of lime on the apparent toxicity of these chlorinated hydrocarbons.

The dehydrohalegenated (partially decomposed forms of DDT) forms of DDT appear to be no less toxic in some case, or more toxic to some plants, as lima beans and snap beans, than the para para prime DDT and the ortho para prime DDT. Dehydrohalogentation occurs in the process of breaking down of the DDT molecule and is probably the only decomposition that occurs. This seems to indicated that toxicity to certain crops can be expected once a residue of these chlorinated hydrocarbons is accumulated in the soil. We have results suggesting the possibility that the application of dolomitic lime to the soil may dehydrohalogenate different forms of DDT, thereby increasing their toxic effects. There is also considerable suggestive evidence to indicate that possibly each of these chlorinated hydrocarbons may require different optimum soil pH reactions for optimum toxicity effects.

Because of rather startling results we have observed under our experimental conditions we feel it is imperative that much careful work be done under a wide variety of soil, crops, and climatic conditions. Such work should determine what hazards may be in accumulating soil residues of the substances in question and develop, if possible, methods for prevention or correction of such effects as might occur.

Sincerely yours,



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